UNIVERSITÄT DUISBURG ESSEN
Offen im Denken

Fachgebiet Hochfrequenztechnik

H F T

Fachbereich Ingenieurwissenschaften
Abteilung Elektrotechnik und Informationstechnik

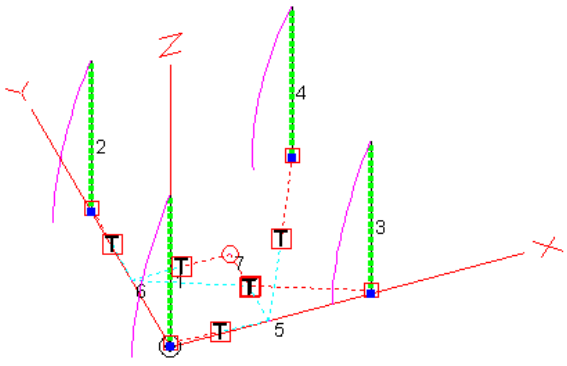
Prof. Dr.-Ing. K. Solbach
Prof. Dr.-Ing. A. Beyer

Bachelorarbeit

Phased Array Antenna for Short Wave Communication (oder Projektarbeit)

In short wave communications (3 – 30 MHz) single dipole and monopole antennas are used or even small array antennas which can increase the gain in a favored direction and suppress interference from the opposite direction. One such practical array antenna with switchable beam direction is the *Four Square Array* which employs four vertical monopole antenna elements arranged in a square of quarter-wave spacing. In order to realize a directive radiation pattern with a large front-to-back ratio the elements have to be fed equal currents with phase differences of 90° and 180°. Scanning of the beam direction can be performed by cyclically switching the phases of the elements. The feed currents have to be derived from the transmitter power by a feed network which performs power division, phase control and impedance matching.

The task is to build such an array feed network for an array of monopole elements for the 7 MHz amateur radio band. The feed network together with the antenna array will be mounted to our roof antenna platform above 12th floor of BB building where testing of the achieved current excitation and antenna patterns can be performed and where the array can be operated as part of our amateur radio club station.



The task of this thesis is to simulate the antenna element impedances and design and simulate a suitable feed network taking into account the impedances. One suitable simulation tool for the antenna impedance is EZNEC and a tool for the calculation of the details of one possible feed network design is available as Arrayfeed. In a next step, a circuit board is to be generated for the feed network including the switching circuit on the basis of electro-mechanical relays. For the remote operation of the antenna scanning a driver circuit with direction indicator has to be built. Lastly, the network can be tested in the lab using equivalent impedances to replace the antenna elements before installation with the real array and testing.

The task entails the following steps:

1. Familiarize with the theory of the *Four Square Array* and the function of the feed network; see in particular the *ARRL Antenna Book* .
2. Simulate the antenna element impedances using the EZNEC simulation software. Compare to measurements of the impedances of the real antennas on the roof platform.
3. Design the feed network circuit and simulate the array including the designed circuit.
4. Familiarize with EAGLE, the CAD tool for the design of printed circuits boards, using the EAGLE tutorial.
5. Transfer the feed network circuit to the board layout in EAGLE and optimize positions of components.
6. Deliver the PCB data set to the in-house PCB workshop which will provide the PCB. Assemble the components to the fabricated PCB and test the functionality of the circuit.
7. Design and build the remote control switch circuit based on a mechanical rotatable switch with diode logic, LEDs for position indication and a small dc power supply.
8. Measure the realized current excitation to the array elements using equivalent R-L-C circuits at the lab and compare to the simulated (design) predictions using a Vector Network Analyzer.
9. Transfer the feed network to the real antenna array and test the current excitations at the monopole feed points and verify proper operation of the antenna by checking directional scanning with received signals at the 40 meter amateur radio band.

After delivery of the thesis, a public presentation of the results is to be given at the HFT department.